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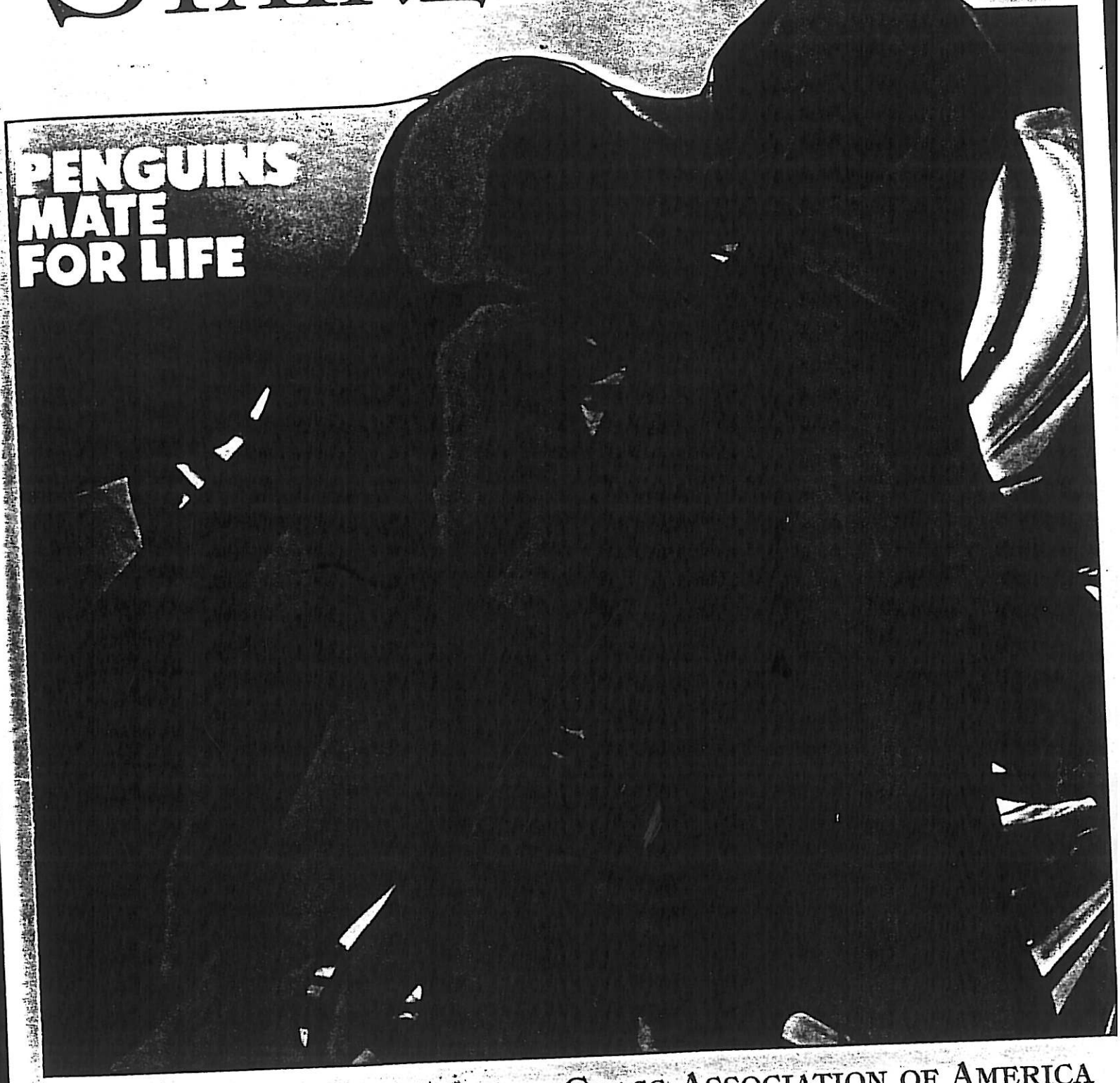

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Protective Glazing
for Stained Glass Windows

Inspired Partnerships, a not-for-profit organization based in Chicago, IL, received a $34,320 grant from the National Preservation Center in October 1994 to investigate the virtues and liabilities of various protective glazing installations over stained glass. The study was conducted over an 18-month period from October 1994 to April 1996 and addresses energy, security, sound and light transmission and aesthetic and conservation issues surrounding the use of protective glazing. Although some aspects of this research are applicable to all protective glazing, the study concentrated on the virtues and problems associated with installations over stained glass in houses of worship. Churches and temples have specific energy, maintenance and security concerns which tend to be unique to their function, management and operation.

"Protective glazing" (PG) is defined as a secondary layer of sheet glass or plastic on the exterior of a stained glass window. PG is also described as "storm," "double," "outer" and "secondary" glazing, and these terms are used interchangeably throughout the study. "Stained glass," for the purpose of this study, pertains to all types of leaded glass. In addition to research, the study included: 1) a stained glass studio survey; 2) a field survey of 100 protective glazing installations in four different U.S. regions; 3) *in situ* testing of two protective glazing installations; 4) an energy model of an intermittently heated building, and 5) the alteration of 10 protective glazing installations.

Many stained glass studios and window contractors endorse the use of protective glazing in their trade literature, while manufacturers of laminated or tempered glass and of acrylics or polycarbonates promote the advantages of their products. Yet, protective glazing may be causing serious damage to many stained glass windows across the country by increasing condensation and heat buildup in the air space and by preventing maintenance.

The information presented in this article comes directly from a recent study of protective glazing as used by the stained glass industry. This study, conducted by Chicago-based Inspired Partnerships and funded by the National Preservation Center, a division of the National Parks Service, represents one of the first scientific examinations of the effects of protective glazing on stained glass in America.

There are conflicting opinions among stained glass contractors as to the merits, potential problems and proper installation of protective glazing. While theories and opinions abound, American studies to develop and perform scientific field surveys and tests to separate myth from fact have not been present prior to this study. It is the intention of this study by Inspired Partnerships to frame the debate about protective glazing, dispel many of the misconceptions regarding its usage and to recommend appropriate installation methods when protective glazing is required.

Inspired Partnerships has been documenting protective glazing installations since 1991. Inspired Partnerships has found that some installations surveyed appear to cause no harm to the stained glass, while others appear to cause serious harm. Basic factors such as the age of the installation, window orientation, installation details, humidity and lighting measurements were recorded during field inspections to develop baseline data. However, because of weather and installation variables, these efforts were too limited to establish clear patterns and accurate information. While most of the members of the stained glass industry agree that protective glazing should be vented in some manner, it seems that venting is rarely present in the field.

The intended audience of Inspired Partnership's final report—primarily owners of historic churches, synagogues, mausoleums and civic buildings in America—are the target of numerous claims which encourage protective glazing. Vandalism, street noise, energy losses and unusual deterioration circumstances all play a role in its use, yet data is unavailable to make an educated judgement for the proper specification or application of protective glazing. Also, protective glazing is often improperly installed, thus threatening America's stained glass treasures.

The research presented in Inspired Partnerships' study may affect stained glass stewards' spending on protective glazing and may contribute to the elimination of the practice of installing protective glazing when restoration would be more appropriate. Most importantly, it is hoped that a published record backed by hard facts may

convince owners to protect stained glass properly for future generations. This study indicates that the continued practice of installing improperly ventilated protective glazing is creating a myriad of preservation problems, with the result being the potential loss of many historic stained glass windows.

Protective Glazing Project Scope

In order to accomplish the project goal of promoting higher industry standards for the proper use and installation of protective glazing, the project committee developed a list of claims to address the myths, facts and hearsay surrounding protective glazing. The committee also developed the following project objectives:

1. Perform an international literature search on protective glazing over stained glass.
2. Provide an historical overview of the development of protective glazing in America.
3. Inspect and evaluate a cross section of protective glazing installations in America.
4. Create protective glazing models addressing energy performance and interspace conditions.
5. Prepare manuscripts to publish for professional preservation and lay audiences.
6. Disseminate the study through the building, preservation and religious networks.
7. Identify additional research and testing to be undertaken.

Results of International Literature Search

Protective glazing research in the United States cannot be discussed in context without having a firm understanding of subsequent twentieth-century research in Europe, spearheaded by the Corpus Vitrearum Medii Aevi (CVMA). The CVMA, an international research organization dedicated to scientific work concerning medieval stained glass, has held biannual seminars since its inception in 1952. In 1962, a committee within the CVMA was formed to conduct research on materials and techniques used in medieval stained and painted glass, and to establish principles and guidelines for conservation and restoration of these [stained glass] endangered works of art.

Although the CVMA initially consisted of mostly art historians, membership now includes conservators, restorers and scientists. Some time ago, a CVMA newsletter stated that "protective glazing is the most effective instrument of conservation [of stained glass] known at present."

Much of this research during the 1970s and 1980s can be attributed to Roy G. Newton, who wrote *The Deterioration and Conservation of Stained Glass: A Critical Biography* (1982), which remains among the most important sources on glass conservation to this day. It is important to note that the CVMA and its research are concerned only with medieval stained and painted glass. The question is whether these same circumstances apply to stained glass manufactured and painted since the Industrial Revolution.

When the Corpus Vitrearum was formed in Europe in 1952, some U.S. museums were interested, as medieval stained glass is found in most—if not all—of the more prominent American museums. For obvious reasons, academic art historians involved in teaching medieval art, architecture and literature were also interested in research carried out by the CVMA. A subsequent survey of medieval stained glass in the United States and the formation of a group involved in the survey, The Census of Stained Glass Windows in America, was the vehicle by which European research findings about protective glazing became more widely known.

Stefan Oidtmann's recently published dissertation, *Die Schutzverglasung—eine wirksame Schutzmassnahme gegan die Korrosion an wertvollen Glasmalerieien*, Technische Universiteit Eindhoven (December 6, 1994), is the most extensive resource on protective glazing to date. Unfortunately, as a dissertation, only a very limited edition has been published in German. However, parts of this dissertation were translated for Inspired Partnerships to aid in the present study. This book provides an excellent summary of conservation work at various European cathedrals but is generally limited to medieval stained glass conservation as related to moisture problems.

Nearly all European research has concentrated on moisture-related conservation issues and has generally surmised that "isothermal" (a system which inhibits the conduction of heat from the exterior surface to the interior surface) protective glazing installations are the only way to protect medieval stained glass from deterioration. Such applications are fundamentally and economically impractical for the vast majority of post-industrial stained glass in America.

British stained glass expert Roy G. Newton was among the first to rejuvenate the century-old concerns over protective glazing in a CVMA Newsletter in April 1975. Lawrence Lee followed suit and included a brief mention of protective glazing and its associated problems in his book entitled *Stained Glass* (Crown Publishers, New York) in 1976. Lee noted that "experts recommend that for important windows, protective plain glass should be inserted into the window openings with the precious ancient glass remounted a little way inside." This book generally refers to medieval glass. Nevertheless, Lee discusses condensation and aesthetic concerns as well as isothermal installations. This was the first time protective glazing problems were mentioned in a U.S. publication.

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An article in *Stained Glass Quarterly* (Winter 1983/84) discussed venting protective glazing to the interior but is restricted to museum settings. This and subsequent issues discussed how protective glazing might be damaging to stained glass windows.

Julie Sloan boldly asked "Protective Glazing: Is It Necessary?" in her February 1987 article in *Professional Stained Glass.* Many important observations were presented in this review; however, the only research Ms. Sloan cited was *The Deterioration and Conservation of Stained Glass: A Critical Biography.* While the CVMA was not mentioned specifically, most of the information cited came from their research findings.

In 1988, The Census for Stained Glass Windows in America published a booklet entitled *Conservation and Restoration of Stained Glass: An Owner's Guide.* Geared toward the caretakers of our nation's stained glass—ministers, church custodians and church lay committees—the booklet contained a short discussion on protective glazing. "Protective glazing systems, when correctly installed, may greatly increase the longevity of historic glass and may decrease the overall energy requirement of the buildings. When incorrectly installed, protective glazing may detract from the aesthetic beauty of the windows and the building and may set up conditions which may actually destroy the glass." It is significant that leaded, laminated and tempered glass with venting was encouraged while acrylics and polycarbonates without venting were discouraged.

Stained Glass Magazine, *Glass Art, Old House Journal, Traditional Building, The Clergy Journal* and several not-for-profit preservation newsletters such as *Common Bond, Inspired* and *Amazing Space* have printed articles since the mid 1980s detailing the hazards of protective glazing. These articles were backed by personal experience and observations but lacked American research data to contradict unsubstantiated claims made by protective glazing manufacturers and installers.

The SGAA Reference & Technical Manual: A Comprehensive Guide to Stained Glass, First Edition had an article (reprinted from *Stained Glass,* Summer 1982) by Viggo B.A. Rambusch, in which he stated that "protective glass or acrylic plastic is very important... care should be taken in selecting the framing system... note that plastic is not flat but is rather wavy... weep holes or other venting systems [are necessary] for the air pocket between the stained glass and the protective element." Several articles with references to protective glazing were reprinted for the 1992 *Manual.* However, even the most comprehensive book (785 pages) on stained glass in America contains contradicting statements on protective glazing installations pertaining to venting the air space. Nevertheless, it includes several important points regarding protective glazing:

1. It is not a substitute for repair, restoration or maintenance.
2. The airspace should be vented to allow for any condensate to evaporate, to equalize air pressure and to minimize the temperature gradient.
3. Ventilation methods are discussed.
4. If plastic glazing is used, adequate provision must be made for significant expansion/contraction.

Copyrighted in 1993, *Conservation of Stained Glass in America: A Manual for Studios and Caretakers,* by Julie L. Sloan, was not printed until January 1995. Much of the text is taken from previous articles by the author in *Professional Stained Glass* and other publications, while the entire last chapter is dedicated to protective glazing.

The Stained Glass Association of America's Restoration and Repair Committee recently published *Standards and Guidelines for the Preservation of Historic Stained Glass Windows* (copyright February 1995). In reference to protective glazing, this resource summarizes:

1. Promotion of protective glazing to save money due to energy conservation is not correct; the majority of American windows fabricated after 1850 do not need protective glazing.
2. Exceptions are windows containing fragile paint,

windows composed of large, very thin pieces of glass and some plated windows with irregular exterior plating that may encourage the infiltration of water between the plates.

3. Primary purpose of protective glazing is to protect the window from vandalism and severe weather conditions.
4. The interspace must be vented with screens, preferably to the exterior at the extreme bottom and top of the protective glazing, to encourage the movement of air through the interspace.

In recent years, the voices of numerous stained glass and preservation professionals have begun to congeal into a solid message that protective glazing is not a substitute for restoration and, when improperly installed, can detract from the building's aesthetics and accelerate deterioration.

Promotion and Use of Protective Glazing

Protective glazing for stained glass has been used in America since the late nineteenth century; however, it did not become popular until after World War Two, when it began filling the void caused by a waning stained glass industry. The civil rights demonstrations of the 1960s and the energy crisis of the 1970s acted as a catalyst, and protective glazing evolved into a multi-million dollar industry.

The ever-changing face of religion (fewer active members), architecture (less complex designs), art (less ornamentation) and economy (less money) since the 1960s has resulted in greater competition for fewer stained glass installations.

In order to stay in business, many stained glass studios and other window contractors have fully endorsed the use of protective glazing by stating that the only economical method of halting water seepage in an old window is to install permanent protective glazing. The installation of protective glazing has become a lucrative aspect of the glazing industry across the country. Stained glass studio literature collected since the 1960s reveals that most studios used at least some of the following reasons to promote protective glazing to consumers:

1. vandalism
2. security
3. energy savings
4. comfort
5. conservation
6. weather damage
7. sound barrier
8. less maintenance is required

The results of this study show that claims of saving 50% on energy bills or quadrupling the life of stained glass by using protective glazing are unfounded. No reliable studies substantiate such claims, including this one. This study encourages professional presentation of what storm windows can and cannot do for stained glass.

Most studios have mentioned protective glazing in advertisements and company brochures over the past several decades, which provided an opportunity to review how protective glazing is represented in company literature. The following sampling provides an array of promotional methods:

A contracting bid (not public information) from one stained glass studio lists the following advantages of using Lexan® as protective glazing: *"reduce heating costs, reduce cooling costs, protect wooden millwork and eliminate need for continual repainting, protect valuable windows from vandalism... can quadruple your stained glass window life expectancy and save your congregation money every day."*

Bovard Studio's (Fairfield, IA) 1991 newsletter provides a comprehensive view of protective glazing: *"Benefits of protective glazing are energy conservation, protection... from vandalism, protection of stained glass leading and frames from deterioration caused by weathering, hailstones and pollution. But beware, improperly vented protective glazing can create more damage than vandals throwing rocks.... If condensation and humidity are not alleviated by proper air circulation, the leading and metal frame deteriorate to the point where structural integrity of the window is lost. Protective glazing alone is not a restoration technique or an alternative to proper maintenance of stained glass."*

Rohlf's Stained and Leaded Glass, Inc. (Mt. Vernon, NY) printed a brochure which states *"Clear float, safety or tempered glass should be used for protective glazing. Acrylic or polycarbonate should only be used in areas of severe vandalism, due to yellowing, frosting and not allowing the wood to breathe."*

David Wixon & Associates (Glen Ellyn, IL) printed a newsletter entitled "Stained Glass Technical Advisory" that reads *"DANGER ALERT!"* and contains three pages dedicated to the problems associated with improperly installed double glazing.

Consumer Demand for Protective Glazing

A series of events in the 1960s and early 1970s greatly intensified the use of protective glazing in the United States. Civil unrest throughout the South and large northern cities motivated a number of congregations to cover their stained glass windows with protective glazing in fear of vandalism.

One church in Savannah, Georgia, reported that the all-white congregation had protective glazing installed during the early 1960s in direct response to verbal threats of destruction for their segregated philosophy. A Detroit church installed protective glazing in response to bullet holes in their stained glass during the 1967 riots. Fear over vandalism and theft—whether justified or not—remains a powerful motivator for protective glazing, especially in inner-city neighborhoods.

The 1973 oil embargo greatly increased the cost of fuel oil, convincing many churches to add secondary glazing to conserve energy. In the January/February 1976 issue of *Your Church* magazine, a total of 338 persons responded to the property-management survey. The survey asked whether the church had protective glass over the stained glass. Of the 70% who answered the question, 41% said their churches either had some form of protective glazing or they were thinking about adding it.

Field surveys by Inspired Partnerships estimate that 90% of the stained glass in Northeast, Midwest, and Rocky Mountain churches are covered with protective glazing and that 70% of the stained glass in Southeast, Southern and West Coast churches have protective glazing.

Perhaps even more important than the fear of vandalism or the concern over fuel bills is the financial inability of many congregations to fund stained glass restoration. The enormous popularity of stained glass in America between the Civil War and World War I resulted in countless large stained glass installations now between 80 and 130 years old. It is important to note that the life span of most leaded glass windows falls into this time span. Many dwindling congregations housed in large, old churches are faced with the reality of expensive restoration costs and choose to defer the expense of restoration, instead taking the protective glazing alternative over restoration.

Regardless of the aesthetic or conservation impact on stained glass, protective glazing stops leaks and drafts through deteriorated stained glass and postpones the inevitable restoration costs for someone else. Procrastination has been the decision of thousands of congregations across the country, and today a vast majority of U.S. churches with stained glass have some type of protective glazing. In recent years, a greater sense of stewardship, increasing professional criticism of protective glazing and a growing "restoration" market is prompting the question, *Do we need protective glazing... or do we really need restoration?*

Protective Glazing Questionnaire

Inspired Partnerships solicited input from the stained glass industry as part of this study through a questionnaire published in the Winter 1995 *Stained Glass* Magazine. A similar questionnaire survey was mailed to the Studio and Artist/Designer members of the SGAA, various known stained glass artists who are not SGAA members and non-profit religious and preservation organizations who will benefit from the study. Some questionnaires were sent to European individuals involved in protective-glazing concerns over the years. Approximately 200 questionnaires were mailed or faxed (180 to stained glass practitioners and 20 to other interested parties), yielding 40 responses, all from stained glass studios. Disinterest and reticence over taking a position before the final, published results of the study are available ostensibly reduced the number of responses.

However, the 40 studios who responded literally represent hundreds of protective-glazing installations per year and thousands of protective-glazing installations over the life of their companies. Some questions involved multiple responses, while others were answered by short essays. Moreover, some respondents chose not to answer certain questions. Therefore, the final results are not scientific but a general representation of the U.S. stained glass community. The geographic distribution included 17 states, Canada, England and Yugoslavia.

Over 62% responded "always or nearly always recommend the use of protective glazing," with about the same number doing the actual installation. The decision for or against protective glazing was almost equally made by the client or the studio.

Reasons for encouraging protective glazing ranged from 75% citing vandalism, 50% citing hail or high winds and 50% citing energy savings. These reasons represent the most common concerns expressed by congregations. Another 35% cited security or protection from glass deterioration. The top three reasons cited for discouraging the use of protective glazing included: 35% negative impact on aesthetics, 25% condensation in the air space and 25% heat buildup in the air space.

Nearly half of the respondents noted that they ALWAYS vent their protective-glazing installations. However, the national protective-glazing field survey strongly contradicts this response. Half of the studios which responded do not offer any guarantees on their protective-glazing installations; only 18% offer a guarantee over five years. Polycarbonates (e.g. Lexan®) are used most often for protective glazing, while standard sheet or plate glass were next. All materials considered, the use of glass and plastic products were equally divided among the respondents.

The controversy in literature and seminars involving venting is a concern of many respondents. The source of industry information about protective glazing indicates that

nearly 85% of the respondents glean their information from stained glass publications or commercial glazing publications. Others rely on "word of mouth."

Very few respondents answered all the questions, choosing instead to ignore those questions which involved something other than simply checking a box. One respondent who declines the use of the firm's name in this study stated that the firm doesn't really recommend protective glazing—they just do it to make money. "When a church calls and wants it done, they are going to have someone do it, and it might as well be us."

Several firms discourage the use of plastic materials, unless vandalism is a major problem. Eventual yellowing, clouding and scratching were the reasons stated. One respondent felt that "acrylics hold their clarity much better than polycarbonates when exposed to intense Florida sun." Of the three respondents from Florida, two always vent (to the exterior), while one never vents; however, this studio is waiting for more definitive research on American stained glass.

Most of the respondents had been installing protective glazing since 1970. Another 20% were installing protective glazing in the 1940s-50s-60s, while only three of the respondents installed protective glazing prior to 1940. The vast majority of the respondents were small studios of fewer than five people working full time.

It was disappointing that only one of the ten largest studios in America responded to the questionnaire. Nevertheless, it was little surprise since these studios tend to rely on larger contracts, which include more storm glazing—they also tend to promote protective glazing more in studio literature and have voiced more opposition to this study.

Protective Glazing Field Survey

A field survey of 100 protective glazing installations from four different cli-

matic regions of the U.S. was performed to establish a representative pool of examples. Three primary aspects were evaluated in the field survey:

1. condensation
2. heat build-up
3. aesthetics

Ten protective glazing installations in Chicago were removed, modified or replaced to determine the effect of protective glazing over time, to determine changes that occur when unvented protective glazing is vented or removed altogether and to experiment with various installation methods. These "case studies" were evaluated further for deterioration, light and sound transmission and installation methods in collaboration with professional contractors and stained glass studios in Chicago.

Summary of 100 Installations

Inspired Partnerships performed a field survey of 100 protective-glazing installations from March 1995 to March 1996. The Committee suggested four regional areas to be surveyed based on their climate, concentration of protective-glazing installations and potential for minimizing travel costs. These sites consisted of: Portland-Tacoma-Seattle in the Northwest (temperate/wet); Tucson-El Paso-Albuquerque-Phoenix (hot/dry) in the Southwest; Chicago in the Midwest (cold/wet), and Savannah-Charleston in the South (hot/wet).

Each area provided valuable insight on protective-glazing installations and collectively gave a strong national perspective on the protective-glazing industry, which is summarized below. In addition, five of the nine members of the Advisory Committee have considerable professional experience in the Northeast and Mid Atlantic areas as well, including Boston, New York City, Philadelphia and Washington, D.C.

The Committee developed the following criteria for selecting protective-glazing installations in the field:

1. Variety of window settings (wood, masonry, steel)
2. Variety of stained glass (painted glass, plated windows)
3. Variety of protective glazing (acrylics, polycarbonates, glass)
4. Variety of aesthetics (good, bad, mediocre)
5. Variety of installations (vented, unvented, fixed)

The Committee also established the methodology to use during the field survey of the 100 protective glazing installa-

tions using a survey form developed by Committee member Arthur J. Femenella:

1. Surface temperature of glass & lead (when feasible)
2. Outside and inside ambient temperature
3. Outside and inside ambient humidity
4. Relative humidity in air space (when feasible)
5. Description of installation and general conditions
6. Expanded visual inspection/comments on condensation
7. Date and time measurements were taken
8. Orientation of window
9. Document and photograph all installations
10. Note weather conditions

An effort was made to select protective-glazing installations at random, which was a necessity due to limited travel costs in every region but Chicago. Most installations were selected on a first-seen basis, while trying to adhere to the selection criteria developed by the Committee. The 25 installations in Chicago, however, were essentially hand-picked from the thousands of available installations based on the selection criteria.

In terms of window orientation, the survey was concentrated on the east (31%), south (40%) and west (27%) windows, since north windows are not affected by solar gain in the Continental U.S. Among the windows surveyed, 40% are a simple rectangular or round arch window, while 60% are gothic arch or rose windows with tracery.

Window height from the ground was recorded, since improved security is often cited to warrant protective glazing; 22% are within five feet of the ground, 30% are between five and ten feet above ground and 48% are more than ten feet above ground (up to 40 feet).

The exact type of protective-glazing material was recorded when it could be determined; otherwise it was simply grouped into plastics (23%) or glass (27%). The breakdown of protective-glazing materials employed is: polycarbonates (31%); acrylics (14%), tempered glass (3%), laminated glass (1%) and fiberglass (1%). Therefore, as a group, plastic products accounted for approximately 70% of the windows surveyed. The age of the installation was also recorded when known.

Field Survey Overview

Group A, Pacific Northwest (surveyed in April 1995):

There are fewer pre-W.W.II churches in the Northwest compared to other areas in the country, and (perhaps due to limited sunshine) there are comparatively few stained glass installations.

This area took several weeks to survey since sunshine was sparse, yet necessary to test for heat buildup and surface temperature of the stained glass. One of the oldest protective glazing installations found in the Northwest was located at the Congregation Beth Israel synagogue and appears original to the 1927 construction. Despite the mild Northwest climate, most of the stained glass is covered with protective glazing. Due to predominately mild temperatures, ventilators are found on only 25% of the stained glass windows, so protective glazing has less impact on church ventilation than in many other regions in the U.S. None of the churches surveyed had air-conditioning.

The most obvious problem with protective glazing in the Northwest was the creation of an interspace which traps moisture in a very damp climate. Evidence of moisture was readily apparent on 80% of the installations, and over 20% of the frames had some degree of corrosion or rot.

Group B, Southwest (surveyed in June 1995):

Protective-glazing installations were difficult to find in the Southwest; doing so required an 800+ mile trek through Arizona, New Mexico and southern Colorado. The extremely dry climate revealed fewer problems with condensation. When present, condensation seemed to be related to air-conditioning or evaporators known as "swamp coolers."

The Southwest churches generally had lower roofs with wider overhangs that shaded the side walls and stained glass from direct sunlight. However, the intense sunlight on exposed windows, particularly plastic materials with high coefficients of expansion/contraction, was consistently causing the failure of perimeter sealants. Despite the blistering daily temperatures, which often exceeded 90°F during the field survey, few of the windows surveyed had deformation problems.

GROUP C, CHICAGO AREA (SURVEYED BETWEEN MARCH 1995 AND MARCH 1996):

There are literally thousands of protective-glazing installations in the Chicago area, yielding the greatest variety of installations to select from. Chicago's high crime and vandalism rate is approximately the third worst in the United States. This fact, coupled with brutal winter weather, has encouraged the vast majority (over 90%) of churches to cover their stained glass with protective glazing. Most of the stained glass in Chicago was installed during the late nineteenth and early twentieth centuries and is between 80 and 100 years old. Protective-glazing installations also tend to be older in the Chicago area than the other three areas surveyed, with installations dating back to the early twentieth century.

The condition of stained glass in Chicago, whether covered by protective glazing or not, is also worse than the other three regions surveyed. Demographic shifts and suburban flight have left many inner-city churches in disrepair with very limited resources. Expensive stained glass repair is often near the bottom of their building priorities. It is for that reason that in Chicago, more than in any other region surveyed, protective glazing is often seen as a stopgap measure to postpone restoration.

GROUP D, SOUTHEAST (SURVEYED IN JULY 1995)

Charleston, SC, and Savannah, GA, were selected for their concentration of historic churches, strong preservation movement, good church documentation and vulnerability to hurricanes.

Surprisingly, several of the churches without protective glazing suffered no stained glass damage from Hurricane Hugo in 1989. Other windows covered with protective glazing actually had the entire window (including the frame) blown out of the window opening.

Exposed stained glass is very resistant to wind pressure but is vulnerable to flying objects. The vast majority of stained glass damage resulting from Hurricane Hugo was caused by flying roofing and siding materials, branches or debris hurled into the windows as opposed to wind or rain from the storm itself.

All but one of the Southeast churches were air-conditioned, and most of the air-conditioning systems were on during the field survey. Combined with high relative humidity (which averaged between 50% and 60%), the air-conditioned interiors were causing the worst condensation problems seen anywhere.

CONCLUSION

In terms of their condition, over half of the installations (both glass and plastic) appeared "dirty." Usually the dirt was found on the inside surface of the protective glazing. Nearly all of the plastic installations are discolored, scratched or hazed, and church members are displeased with their appearance. About 15% are too discolored to see the stained glass at all. The few (5%) of the plastic installations that are not discolored, scratched or hazed are less than two years old.

Approximately half of the installations are set into a sub-frame, typically aluminum, which clashed with the building's historic materials and aesthetics. Another 23% prevent the window ventilators from operating.

Ironically, although responses to the questionnaire signify that most studios vent their protective-glazing installations, only 4% of those surveyed in the field were intentionally vented. Another 19% have self-vented over time due to deteriorated sealants or broken glazing. The depth of the air space varies greatly and is usually contingent upon the window frame and ease of installation; over 75% are set more than 1" from the stained glass.

Condensation is unquestionably a problem with protective-glazing installations, as evidence of condensation was found in nearly 70% of the windows, while 10% of the windows were too obscured to see at all. As expected, the Southwest installations, where the average relative humidity is below 20%, generally had little or no evidence of condensation. Glass temperatures, measured in direct sunlight, were always higher than ambient indoor or outdoor temperatures, averaging between 18°F and 21°F higher. The temperatures varied, depending on the color of the glass, wind speed and how long the window had been exposed to direct sunlight at the time of testing.

Despite recorded heat and condensation problems, the stained glass and glass paints were in good condition overall, while the leading, bracing and frames of the windows were deteriorating. However, a number of these windows have been repaired or braced (many *in situ*) over the past 20 years. These conditions seem to correlate with the quality of the window's construction. High-quality windows by reputable American studios and imported windows (primarily English and German) were in better condition than generic windows. Their superior condition can be generally attributed to better bracing, leading and design. Low-end generic windows with thin (⅛"), flat lead cames were deforming the worst.

Although their internal condition is unknown, none of the plated windows revealed any serious deterioration on the surface. Nevertheless, the waterproofing cement was missing in areas on 40% of the windows and had completely failed on another 22%—regardless of their quality. Moreover, the perimeter sealants had partially or totally failed on half of the protective-glazing installations.

The protective glazing often prevents proper window maintenance; approximately one-third of the windows surveyed required repairs to the metal or wood frames, which were not accessible due to the protective glazing.

The research results attained by Inspired Partnerships and summarized in this article are incorporated in a final study for the National Preservation Center. This study includes: the history, development, use and promotion of protective glazing; its prevalence in America; its advantages and disadvantages; data and photos of the 100 installations inspected during the field survey; detailed case studies of ten protective-glazing installations; final analysis and general specifications for protective-glazing installations and supplemental materials. The intent of this study is to develop a publishable manuscript from the study for professional, preservation and lay audiences after peer review.

This is the first of a series of articles designed to present Inspired Partnerships' findings to the stained glass community. This series will continue with a more in-depth look at protective glazing's history, impact on architecture, effects on energy conservation and impact on restoration of historic stained glass.

Inspired Partnerships first assembled a Protective Glazing Advisory Committee that included the following people: Rolf Achilles, Art & Industrial Historian (Chicago, IL); Arthur J. Femenella, Stained Glass Consultant with Femenella & Associates (Annandale, NJ); Dr. Mark Gilberg, Research Scientist with the National Preservation Center of the National Parks Service; (Natchitoches, LA), Thomas Harboe, Director of Preservation with McClier (Chicago, IL); Barbara Krueger, Stained Glass Artist and Historian (Hartland, MI); Richard Pieper, Restoration Consultant (New York, NY); Andrew Rudin, Energy Consultant (Melrose Park, PA); Dr. Wayne Simon, P.E. (Evergreen, CO); and Neal A. Vogel, Director of Technical Services with Inspired Partnerships (Chicago, IL). Several Committee members served as authors and editors of the final report as well.

Susan Reilly, P.E. of EnerModal Engineering, Inc., was also commissioned by the National Preservation Center to report on the energy value of protective glazing over stained glass. Many other people provided assistance for this study but are far too numerous to mention. However, those who deserve special recognition include: Susanna Aulbach, German Translator; Matthew Bellocchio, Roche Organ Company; Chris Botti and Mike Smoucha, Botti Studio of Architectural Arts; Janice H. Chadbourne, Curator of Fine Arts, Boston Public Library; Richard Cieminski, Jon-Lee Art Glass; Marit Eisenbeis and Charles Kiefer, Inspired Partnerships; Betty Kirpatrick, Hermosa Mountain Studio; Gabriel Mayer of Franz Mayer'sche Hofkunstanstalt, Munich, Germany; Virginia Raguin, Holy Cross College; Jack and David Sussman, J. Sussman, Inc.; Susan Tunick, Friends of Terra Cotta; Theodore Von Gerichten; Kirk D. Weaver, Pittsburgh Stained Glass; and David Wixon, Wixon & Associates. Inspired Partnerships would also like to thank the numerous stained glass studios who provided assistance by completing questionnaires and reporting past experiences with protective glazing.